

Visibility-reducing organic aerosols in the vicinity of Grand Canyon National Park:

1. Properties observed by high resolution gas chromatography

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During the summer of 1989, an air monitoring program was established both within the Grand Canyon and on the South Rim to define summertime organic aerosol concentration and composition as a function of elevation in the canyon. Supporting information was collected on the composition of the inorganic portion of the atmospheric aerosol to help place the relative importance of organics in perspective. The present paper describes that ambient air monitoring experiment, quantifies the bulk chemical composition of the fine ($dp < 2.1 \mu m$) and total aerosol components, distinguishes carbonaceous aerosols according to their organic carbon, elemental carbon and carbonate content, and then examines those characteristics of the organic aerosol that can be defined via capillary gas chromatography using flame ionization detection (GC-FID). At both Indian Gardens (in-canyon, IG) and at Hopi Point (South Rim, HP), the largest contributors to the fine aerosol consist of sulfate and associated ammonium ion plus aerosol carbon species. At IG, sulfate and ammonium ion account for 25.5% and 7.5% of the fine aerosol, respectively, nearly equaled by the 29.9% of the sample composed of organic compounds and 1% contributed by elemental carbon. Somewhat more that half of the fine aerosol at HP can be explained by sulfate ion, ammonium ion, organic compounds and elemental carbon, again with roughly equal mass concentrations due to the ionic versus carbonaceous components. Monthly average mass concentrations for fine aerosol organics were $1.1 \mu g m^{-3}$ (IG) and $1.3 \mu g m^{-3}$ (HP), while the total organics monthly average mass concentrations were $1.9 \mu g m^{-3}$ (IG) and $2.1 \mu g m^{-3}$ (HP). The fraction of aerosol organics that could be evaluated by GC-FID (elutable organics) constituted 27% to 53% of the total organics mass collected as fine or total aerosol. For the fine particle monthly composites, the elutable organics were present in mass concentrations of $0.28 \mu g m^{-3}$ (IG) and $0.46 \mu g m^{-3}$ (HP). At each site, roughly half of the elutable organics fine aerosol fraction was composed of highly polar organic compounds that could be observed by GC-FID only after chemical derivatization prior to analysis. Elutable organics corresponding to the total aerosol size range, were $0.57 \mu g m^{-3}$ (IG) and $1.14 \mu g m^{-3}$ (HP), where the polar organic compounds accounted for 45% (IG) and 38% (HP) of the total aerosol elutable organics.